Bruise Simulation in Peach Grading Lines as a tool for designing Improvement Strategies

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Introduction

The Physical Properties Laboratory (LPF) has been working on the improvement of fruit and vegetable grading lines since 1992[1]. The experience shows that the improvement of grading lines for decreasing mechanical damages has to be approached from two viewpoints: 1) machinery aggressiveness, and 2) fruit susceptibility. Machinery aggressiveness can be characterized as impact probability for different impact intensities assessed by means of electronic fruits (IS-100) [2,5] . On the other hand, bruise susceptibility can be determined using different laboratory tests[3].

A recent study from LPF[4] shows that damage may arise differently in pome and in stone fruits, since: a) pome fruits are mainly stress-susceptible, while stone fruits appear to be more deformation-susceptible, and b) bruise size may be a good predictor for bruise susceptibility in pome fruits while for stone fruits bruise probability is the most relevant characteristic of bruise susceptibility. Also, this study indicates the feasibility of predicting bruise probability using several mechanical and load characterisation parameters. Despite the efforts to establish damage thresholds in peaches[5], no simulation models are currently available for predicting bruise occurrence in grading lines.

Objectives

1.To develop bruise prediction models for *Caterina* peaches gathering load information compatible with that of electronic fruits, as well as mechanical poperties of fruits. 2:To simulate bruise occurrence in a commercial peach grading line by means of bruise prediction models and stochastic information on machinery aggressiveness and mechanical properties os fruits. 3:To extract conclusions on the strategies for machinery improvement by the use of the developed simulation model.

Material and Methods

Data from a previous Project: (PETRI 94-0082, Improvement of Handling Techniques in Stone Fruits) have been used for bruise simulation in grading lines. Two different sets of data were available:

- bruise susceptibility characterisation data corresponding to *Caterina* peaches (number of individuals=720) from seasons 96 & 97
- *in situ* determination of the percentage of bruised peaches (55±6% from a new set of 252 individuals) due to handling through a commercial grading line.

Tests carried out on these samples can be summarised as: characterisation tests (Magness Taylor Firmness-N- and Soluble Solids Content -°Brix-), and bruise susceptibility tests carried out as quasi-static compression for different loading levels (optimal bruise characterisation test for deformation susceptible fruits).

Results and Discussion

Modelling Bruise Probability: As a first step bruise probability was modelled (r^2=0.97, 1st set of data) under a logistic approach using quasi-static load level, hand felt hardness (Force-Deformation ratio at the beginning of loading), and two parameters related to the rheological behaviour of peach tissue (variation of the slope in the Force-Deformation curve at several stages of loading). Subsequently, several equivalencies between the quasi-static load level and the maximum acceleration registered by an IS-100 were attempted.

Simulation Algorithm and Validation: A simulation algorithm was also implemented which generates the probability distributions of all parameters within the bruise prediction models: quasi-static load level/max. acceleration of IS-100, hand felt hardness and rheological behaviour, by means of the Inverse Transform Method with regard to measured distributions (2nd set of data). Parameters related to fruit properties are assigned once in a grading line run, while parameters related to impact level and bruising are assigned as many times as transfer points in the grading line to be simulated. The equivalence between quasi-static and IS-100 load levels which leads to simulated percentage of bruised fruits similar to that of *in situ* measured data on a commercial grading line (55 ± 6% of damaged fruits) was chosen.

Designing improvement strategies for grading lines: Finally, the use of the algorithm for simulating increasing improvements of the commercial peach grading line was tested with results shown in Figure 1. The assurance of impact levels, assessed with an IS-100, below 50g (m/s2) in all line-transfers decreases bruise occurrence from 40% to 20% of handled *Caterina* peaches. Another important feature extracted from the simulation is that no more than 4 transfers with recorded impact intensities, by an IS-100, between 10g and 50g (m/s2) can be assumed for approaching percentages of bruised peaches similar to that of EC-Standards tolerance (10%).

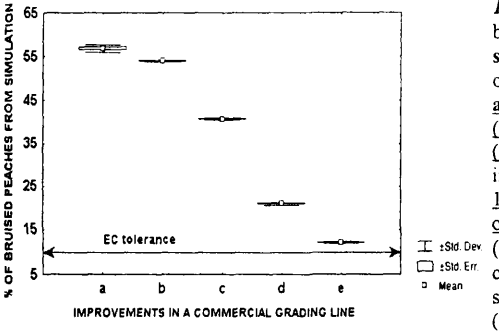

Figure 1. Decrease in percentage of bruise peaches obtained through **simulation of several improvements** of a commercial grading line: **a)**original line, **b)**removal of impacts (100g, 150g], **c)**reduction of impacts (50g, 100g] to half of its original incidence, **d)**total removal of (50g, 100g] impacts, **e)**decrease in number of transfer points from 8 to 4 with (10g, 50g) impacts. Displayed data correspond to an average of 3 simulations per improvement **a)-e)** (5000 fruits each)

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References

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